Chapter 4
Characterization Techniques of Single and Hybrid Nanoparticles

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ABSTRACT

Nanostructures, including nanoparticles, are gaining significant interest due to their wide range of applications. Their size, elemental composition, crystal structure, and physical properties—such as reactivity, mechanical strength, conductivity, and optical behavior—are crucial for determining their performance. Smaller particles have greater surface area-to-volume ratios, enhancing reactivity, while elemental

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composition affects stability and biological compatibility. Crystal structure influences hardness and conductivity, and other factors like shape, surface charge, and modification determine interactions. Various characterization techniques like XRD, SEM, TEM, FTIR, and VSM help analyze these properties. Each technique has its advantages, and combining methods often provides a more comprehensive understanding. Additional techniques, including EDX, UV-Vis, DLS, TGA, and spICP-MS, further enhance analysis by revealing elemental composition, optical properties, stability, and particle size distribution, aiding the development of nanoparticles for advanced applications.

INTRODUCTION

In modern medical field, the use of nanoparticles has become a popular trend. Research about particles ranging from 1 to 100 nm has gained increasing focus because of their diverse uses spanning drug delivery systems and cancer diagnosis and therapy routines, (Brigger et al., 2012; De Jong & Borm, 2008).

As nanoparticles' size, shape, and morphology differ from those of bulk materials, their catalytic qualities get improved. Many types of metallic nanoparticles, such as gold, silver, alloys, magnetic, etc., have wide applications in a variety of industries. (Figure 1). In the fields of biotechnology and medicine, the use of nanoparticles helps in transforming processes, making them more straightforward, secure, affordable, and portable. In current years, nanoparticles have gained interest with their unique qualities, such as their antimicrobial activity and tolerance to extreme heat and oxidation (Hasan, 2015).

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